The Galicia - Ossa-Morena Zone: a new zone of the Iberian Massif

La Zona de Galicia – Ossa-Morena: una nueva zona del Macizo Ibérico

R. Arenas[1], R. Díez Fernández[1], F.J. Rubio Pascual[2], S. Sánchez Martínez[1], L.M. Martín Parra[2], J. Matas[2], J. González del Tánago[1], A. Jiménez-Díaz[3], J.M. Fuenlabrada[4], P. Andonaegui[1] and A. Garcia-Casco[5,6]

1 Dpto. de Petrología y Geoquímica e Instituto de Geociencias (UCM, CSIC), Universidad Complutense. 28040 Madrid, Spain. rarenas@ucm.es
2 Instituto Geológico y Minero de España, 28760 Tres Cantos, Madrid, Spain.
3 Dpto. de Geodinámica, Universidad Complutense. 28040 Madrid, Spain.
4 CAI de Geocronología y Geoquímica Isotópica, Universidad Complutense. 28040 Madrid, Spain.
5 Dpto. de Mineralogía y Petrología, Universidad de Granada. 18071 Granada, Spain.
6 Instituto Andaluz de Ciencias de la Tierra (CSIC, UGR). E-18100 Armilla, Granada, Spain

Abstract: Correlation of a group of allochthonous terranes (referred to as basal, ophiolitic and upper units) exposed in the NW and SW of the Iberian Massif, is used to propose a new geotectonic zone in the southern branch of the Variscan Orogen: the Galicia - Ossa-Morena Zone. Recent advances in SW Iberia identify most of the former Ossa-Morena Zone as another allochthonous complex of the Iberian Massif, the Ossa-Morena Complex, equivalent to the Cabo Ortegal, Órdenes, Malpica-Tui, Bragança and Morais complexes described in NW Iberia. The new geotectonic zone and its counterparts along the rest of the Variscan Orogen constitute an Internal Variscan Zone with ophiolites and units affected by high-P metamorphism. The Galicia - Ossa-Morena Zone includes a Variscan suture and pieces of continental crust bearing the imprint of Ediacaran-Cambrian events related to the activity of peri-Gondwanan magmatic arcs (Cadomian orogenesis). In the Iberian Massif, the general structure of this geotectonic zone represents a duplication of the Gondwanan platform, the outboard sections being juxtaposed on top of domains located closer to the mainland before amalgamation.

Key words: Galicia - Ossa-Morena Zone, New geotectonic zone, Iberian Massif, Variscan Orogen.

Resumen: *La correlación de un grupo de terrenos alóctonos (denominados unidades basales, ofiolíticas y superiores), representados en el NW y SW del Macizo Ibérico, es utilizada para proponer una nueva zona geotectónica en el sector meridional del Orógeno Varisco: la Zona de Galicia – Ossa-Morena. Algunos avances recientes en el SW de Iberia han permitido reconocer que la mayor parte de la anterior Zona de Ossa-Morena representa en realidad otro complejo alóctono del Macizo Ibérico, el Complejo de Ossa-Morena, equivalente a los complejos de Cabo Ortegal, Órdenes, Malpica-Tui, Bragança y Morais, descritos en el NW de Iberia. La nueva zona geotectónica y sus equivalentes a lo largo del Orógeno Varisco constituyen una Zona Varisca Interna con ofiolitas y unidades afectadas por metamorfismo de alta-P. La Zona de Galicia – Ossa-Morena incluye una sutura Varisca y secciones de corteza continental afectadas por eventos Ediacarenses-Cámbricos, relacionados con la actividad de arcos magmáticos peri-Gondwánicos (Orogenia Cadomiense). En el Macizo Ibérico, la estructuración general de esta zona geotectónica representa una duplicación de la plataforma de Gondwana, con los dominios más externos superpuestos en la actualidad sobre otros dominios situados más cerca del continente emergido antes del ensamblado.*

Palabras clave: *Zona de Galicia – Ossa-Morena, Nueva zona geotectónica, Macizo Ibérico, Orógeno Varisco.*

INTRODUCTION

The Iberian Massif, like other sectors of the Variscan Orogen, has been classically divided in geotectonic/paleogeographic zones. In collisional orogens, geotectonic zones can be used to separate different sectors of the colliding continental platforms and tectonic blocks affected by variable intensity of deformation. If well-preserved ophiolites are present, geotectonic zones can also provide information on the oceanic domains closed before collision.

Lotze (1945) and Julivert et al. (1972) made the first geotectonic division of the Iberian Massif, which prevailed for a long time. From northeast to southwest, the Cantabrian, West Asturian-Leonese, Central Iberian, Ossa-Morena and South-Portuguese zones were distinguished. The Cantabrian and South-Portuguese zones represent foreland (external) domains located at the Gondwanan and Laurussian flanks of the orogen, respectively. The rest of the zones show variable intensity of metamorphism and magmatism and thus make the hinterland (internal zone) of the orogen. More recently, Farias et al. (1987) defined a new geotectonic zone within the hinterland of the Iberian Massif, the Galicia - Trás-os-Montes Zone, with far-travelled character and constituted by a gigantic thrust-sheet overriding the Central Iberian Zone. This zone includes several allochthonous

complexes which contain ophiolites and terranes recording high-P metamorphism, and are emplaced on top of a parautochthonous domain also termed Schistose Domain or Parautochthon. The Galicia - Trás-os-Montes Zone shows limited continuity, as it can only be followed in Galicia and along the Portuguese region of Trás-os-Montes. Importantly, this zone contains a Variscan suture, as suggested by the chronology of its ophiolites (Arenas and Sánchez Martínez, 2015) and the high-P metamorphism experienced by some of its units (Abati et al., 2010). That suture zone is apparently rootless, as its trace lies above bedrock geology of Galicia towards the Atlantic Ocean to the West of the Malpica-Tui Complex.

The aforementioned geotectonic division of the Iberian Massif is built on contrasted differentiation criteria from one region to the other, and so it suffers from significant divergences and inconsistencies. It is hence timely a revision of the subdivision that takes into account new advances in the geology of the Iberian Massif and that is based on uniform criteria. In this regard, perhaps the most important problems faced when subdividing the Iberian Massif concern the interpretation of the geology of its NW and SW sections. The SW Iberian Massif, specifically the Ossa-Morena Zone, is characterized by lithological, structural and metamorphic features that are also representative of the Galicia - Trás-os-Montes Zone (Castro, 1987). For instance, the Ossa-Morena Zone contains ophiolites, and units affected by high-P metamorphism of Variscan age. These high-P units of SW Iberia have been recently correlated with equivalent units located in the NW of the Iberian Massif, allowing the proposal for a continuation of the rootless Variscan suture of NW Iberia and the allochthonous complexes of the same region to the W and SW (Díez Fernández and Arenas, 2015). Another consequence of the new correlations across the orogen is a better understanding of the location of the true Rheic suture, which can be clearly distinguished now from other secondary sutures involved in the orogen (Díez Fernández and Arenas, 2015).

EQUIVALENCE BETWEEN THE NW AND SW OF THE IBERIAN MASSIF

The affinity between the continental crusts of NW and SW Iberia was first suggested by Castro (1987). The Ossa-Morena Zone was considered a microcontinent accreted to the Gondwanan margin, represented by the Central Iberian Zone, during a collision in Cadomian times (Ediacaran–Early Cambrian). The allochthonous complexes of NW Iberia would represent transitional parts between the Central Iberian and Ossa-Morena zones, but the Malpica-Tui Complex of NW Iberia and the Central Unit ("Badajoz-Cordoba Corridor") were considered parts of a same lithological unit. In relation to previous correlations, see also Simancas et al. (2009).

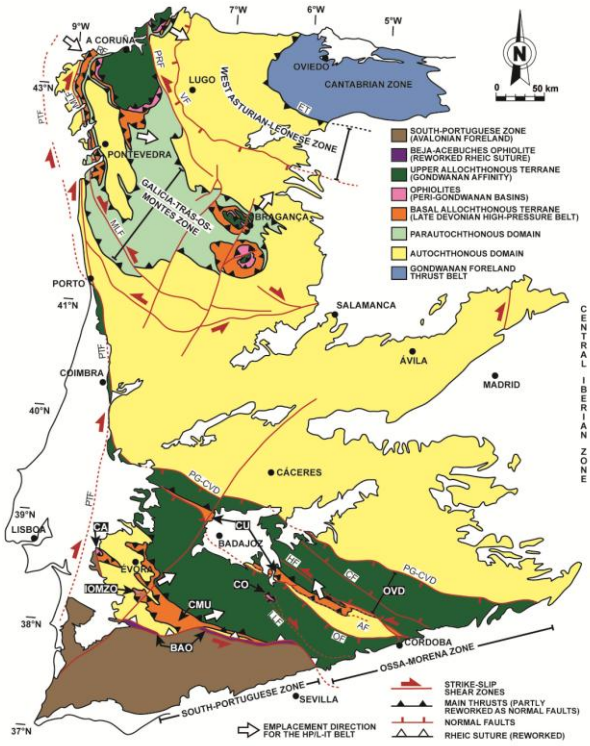

FIGURE 1. *Geological map of the Iberian Massif and correlation of equivalent allochthonous terranes in NW and SW Iberia. Abbreviations: AF, Azuaga Fault; BAO, Beja-Acebuches Ophiolite; CA, Carvalhal Amphibolites; CF, Canaleja Fault; CMU, Cubito-Moura Unit; CO, Calzadilla Ophiolite; CU, Central Unit; ET, Espina Thrust; HF, Hornachos Fault; IOMZO, Internal Ossa-Morena Zone Ophiolites; LLF, Llanos Fault; MLF, Malpica-Lamego Fault; OF, Onza Fault; OVD, Obejo-Valsequillo Domain; PG-CVD, Puente Génave-Castelo de Vide Detachment; PRF, Palas de Rei Fault; PTF, Porto-Tomar Fault; RF, Riás Fault; VF, Viveiro Fault. (Díez Fernández and Arenas, 2015).*

More recently, according to the presence of two high-P belts defining its northern and southern limits, the Ossa-Morena Zone has been interpreted as part of an individual peri-Gondwanan continental microplate, drifted to some extent from the main continent. Such plate was identified as Armorica, a microcontinent that includes sectors of Iberia and Brittany (Azor et al., 2008). The two high-P units would represent rooted sutures related to the dynamics of Armorica and its Variscan accretion, but the real significance of the high-P units remain unclear because an integrated model for their subduction and exhumation has not been presented so far.

However, the lithologies and structural evolution as well as the age and type (HP-LIT) of metamorphism are similar in the basal allochthonous units of NW Iberian Massif and in the high-P units of the SW (Central Unit and Cubito-Moura Unit). Hence, these units can be correlated defining a basal allochthonous terrane with continental affinity and structural continuity from NW to SW Iberia. Considering the high-P record of this terrane, the age of metamorphism (c. 370 Ma) and its structural position below ophiolitic units, this basal terrane has been identified as a

subducted section of the Gondwanan margin and a marker of a long suture zone of Late Devonian age (Fig. 1; Díez Fernández and Arenas, 2015). The ophiolitic units of the Ossa-Morena Zone are still poorly described although, regardless of their age, their structural position suggests a correlation with their structural equivalents in NW Iberia.

One of the corollaries of the proposed correlation of both groups of allochthonous terranes in NW and SW Iberia is that the largest area of the Ossa-Morena Zone, the thick pile of metasedimentary and metaigneous rocks with Ediacaran-Devonian depositional/ crystallization ages, rests on top of a group of units with clear allochthonous nature. The correlations established for the high-P units and the ophiolites, the general synformal structure of the Ossa-Morena Zone and the activity of some significant faults, lead to an important conclusion: most of the central sector of the Ossa-Morena Zone is equivalent to the upper units of NW Iberia, thus representing a large allochthonous unit (Fig. 1; Díez Fernández and Arenas, 2015). Accordingly, most of the Ossa-Morena Zone represents an allochthonous complex of the Iberian Massif, the Ossa-Morena Complex, which should be added to the Cabo Ortegal, Órdenes, Malpica-Tui, Bragança and Morais complexes. The rootless suture of NW Iberia can be therefore followed c. 1000 km south until the limit with the South Portuguese Zone, where the age of the Beja-Acebuches Ophiolite (340-332 Ma) clearly indicates that this is a much younger tectonic limit that transects all the previous nappes (Fig. 1). This interpretation also allows to correlate pre-Variscan events in the upper units of NW Iberia and in the central part of the Ossa-Morena Zone (described as Cadomian), where its remarkable bearing has been widely accepted. Moreover, our proposal implies that some sectors usually included in the Ossa-Morena Zone represent the autochthonous domain of the new allochthonous complex. This is the case of the Sierra Albarrana Unit and the entire structural domain resting below the Cubito-Moura Unit (Fig. 1).

THE GALICIA – OSSA-MORENA ZONE

The geology of NW and SW Iberian Massif can be described in terms of the presence of three different groups of allochthonous terranes, the basal, ophiolitic and upper units (Fig. 1). These terranes maintain the same structural arrangement in both sectors of the Massif, and have comparable lithological constitution and tectonothermal evolution. If this correlation holds correct, it should be accepted that the regions of the Iberian Massif where they appear must be interpreted similarly. However this is not the case so far because the structure of the Galicia - Trás-os-Montes Zone and the Ossa-Morena Zone has been interpreted in rather contrasted ways. Based on the structural and tectonostratigraphic correlation of both zones we propose their merging into a single geotectonic zone of the Iberian Massif: the Galicia - Ossa-Morena Zone (Fig. 2). This new zone would be constituted by the allochthonous complexes of the Iberian Massif, from NE to SW, the Cabo Ortegal, Órdenes, Bragança, Morais, Malpica-Tui and Ossa-Morena complexes.

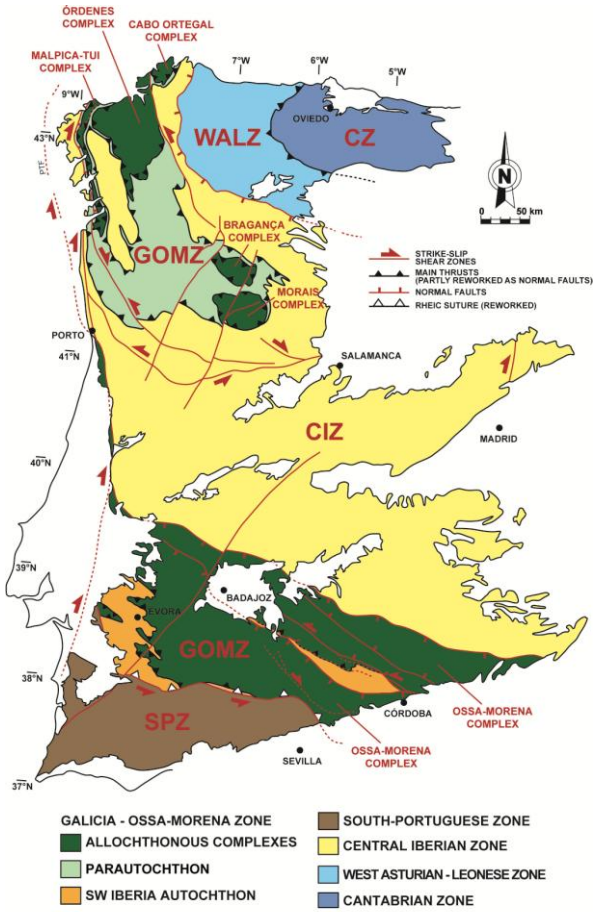

FIGURE 2. *Geological map of the Iberian Massif showing the distribution of the geotectonic zones in which is divided and the new proposed Galicia - Ossa-Morena Zone. Abbreviations: CZ, Cantabrian Zone; WALZ, West Asturian-Leonese Zone; CIZ, Central Iberian Zone; GOMZ, Galicia - Ossa-Morena Zone; SPZ, South Portuguese Zone.*

The allochthonous complexes of the Galicia – Ossa-Morena Zone are emplaced on top of a substrate that apparently shows some different characteristics in NW and SW Iberia. The Parautochthon of the NW section (Fig. 2) does not seem to be represented in the SW, as comparable series have not been described so far. Moreover, sedimentary successions such as the Serie Negra have not been found in the autochthonous sections of Central and NW Iberia, whereas it occurs in the autochthonous domains resting under the Ossa-Morena Complex defined by Díez Fernández and Arenas (2015). On the contrary, some of the metasedimentary rock series represented in the SW show great lithological similarities with the autochthonous sections of the Central Iberian Zone. Therefore, a preliminary distinction could be made between the autochthons of the Galicia - Ossa-Morena Zone, and thence the denomination of SW Iberia

Autochthon is proposed for the domains underlying the Ossa-Morena Complex (Fig. 2). The stratigraphic characteristics of this autochthonous domain are not well known at present, but it likely occupied an outboard position across the margin of Gondwana compared to the autochthon of the Central Iberian Zone (Fig. 2).

The general structure of the Galicia - Ossa-Morena Zone is characterized by the presence of a large allochthonous sheet, thrust onto different domains of the continental platform of Gondwana (Fig. 3). This allochthonous sheet includes the most external domains of the margin of Gondwana. Therefore, the geology of the most internal part of the Iberian Massif accounts for a virtual duplication of the Gondwana margin (Fig. 3). The most external domains of this margin were transported during Variscan convergence above other domains of the Gondwana continental platform closer to the mainland, juxtaposing fairly distant regions with different stratigraphic and paleontological features. The stratigraphic and faunal contrast between the Central Iberian Zone and the Obejo-Valsequillo Domain pointed out by Gutiérrez-Marco et al. (2014) highlights these differences.

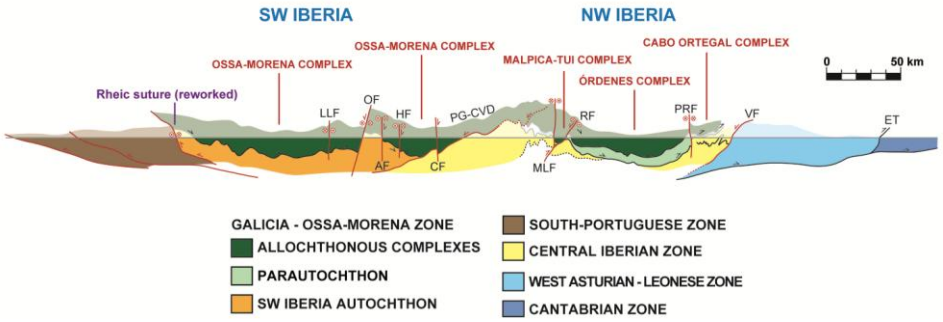

FIGURE 3. *Composite cross-section showing the general structure of the Galicia - Ossa-Morena Zone and its relationships with the other geotectonic zones of the Iberian Massif. Based on the more detailed sections presented by Díez Fernández and Arenas (2015).*

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